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ABSTRACT

This paper presents and discusses the evolution of a metadata-based course portal, the Open Learning Repository (OLR). Different instructional models and learning principles are integrated in order to meet different learning and teaching strategies: different metadata models (domain model, instructional model, cooperative and structural model) are designed and mapped. A scenario-based evaluation of a former version of OLR revealed that the use which was intended by designers and teachers can differ from actual use by learners. In the current version, not only are different instructional principles and theories implemented, but also help-files which address the learners' reflection of their own learning strategies. In the design process, different learning theories as well as the organizational framework serve as relevant context which is addressed by scenarios written by all stakeholders. Scenarios serve as medium for communication between instructional designers, computer scientists, and teaching staff. (Contains 16 references.) (Author)

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Instructional Models and Scenarios for an Open Learning Repository - Instructional Design and Metadata

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Abstract: We present and discuss the evolution of a metadata-based course portal, the Open Learning Repository. Different instructional models and learning principles are integrated in order to meet different learning and teaching strategies: different metadata models (domain model, instructional model, cooperative and structural model) are designed and mapped. A scenario-based evaluation of a former version of OLR revealed that the use which was intended by designers and teachers can differ from actual use by learners. In the current version we do not only implement different instructional principles and theories but also help-files which address the learners reflection of their own learning strategies. In the design process, different learning theories as well as the organizational framework serve as relevant context which is addressed by scenarios written by all stakeholders. Scenarios serve as medium for communication between instructional designers, computer scientists, and teaching staff.

Motivation

Our Open Learning Repositories (OLR for short) are metadata-based course portals, which structure and connect modularised course materials, which can be distributed all over the Web. The modular content is integrated by explicit metadata information in order to build courses and connected sets of learning materials. Modular content can be reused for other courses and in other contexts, leading to a course portal which integrates learning objects from different sources and authors. Semantic annotation is necessary for authors to help them choose Learning Objects and to connect them into course structures. We use a relational database to store all metadata. We don't store content in the database itself, but reference it by URLs. We are currently using the OLR system in the context of two courses, one in Artificial Intelligence and one in Software Engineering.

The focus in the first and second generation of our Open Learning Repositories (Dhraief et al., 2001) was the technical infrastructure. The main questions were, how to store the metadata, whether to use O-Telos (Mylopoulos et al., 1990), XML or RDF (World Wide Web Consortium, 1999) etc. We also implemented different navigation interfaces. Different views on a given course are offered to students, realized by different queries and page designs. A user has the choice between a hierarchical tree-like navigation, a trail navigation, where he can move forward and backward on a trail, and semantic (context) net navigation.

However, there was a lack of pedagogical background in the first and second generation of OLRs. Therefore we decided to design and implement a new generation of OLR, which we call OLR3. In a team of computer scientists and educational researchers we focused explicitly on the goal to use such an open learning repository to enhance teaching and learning. We have implemented different instructional models and extended the Learning Object Metadata Standard LOM (IEEE Learning Technology Standards Committee, 2002) to incorporate our strong focus on educational theories. Also, as the results of the evaluation of the second generation of the Open Learning Repository revealed that the system did not meet the students needs, we addressed the entire educational setting which is supported by technology instead of focussing on the technology in an isolated way. For this, we developed a scenario-based approach to guide the design process of OLR3 in order to address both the technology as well as the educational setting, which influences the use of an e-Learning system. The multi-disciplinarity of the project team required a medium for communication that allows to communicate ideas and theories beyond the different areas of expertise. The scenario-based approach helped to handle this task.

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The Open Learning Repository (OLR3): Technological Aspects

In this chapter, we will give an overview on the architecture of the 3rd generation of OLR, its current functionalities, and its web interface.

Architecture and Technology

The 3rd generation of our Open Learning Repository, OLR3, is implemented in Java and works as a JavaServlet, running on an Enhydra (Madl et al., 2002) Application Server (which has been developed as open source). It is connected to an Oracle Database via JDBC, which is used to store the metadata entered by course authors and students. There are two types of metadata: structure-metadata and annotation-metadata. The structure metadata represent information about the structure of a given course or course unit, the navigation path within this course or course unit and the relations between different learning objects. Annotation metadata represent the information about the content itself. We are using (a subset of) the LOM metadata standard to annotate the learning objects. All metadata are represented in RDF and RDFS (World Wide Web Consortium, 2002). The RDF schemes, needed for either the annotation or the structure of learning, can resided anywhere on the Web, as do the learning objects. The database does only hold the metadata, and assembles the course from these data., which

The system works on a "StatementPool",which holds all metadata known to the system at runtime, relevant for a given course. When an author starts working on a course, the pool is filled with the already existing data about that course from the database, and all statements from the used RDF schemes. Any referenced RDF schema will be parsed using the SiRPAC RDF parser (Melnik, 2001), whereas imported RDF files are parsed by a VRP RDF parser (Tolle, 2001), which provides semantical checks against given RDF schema rules.

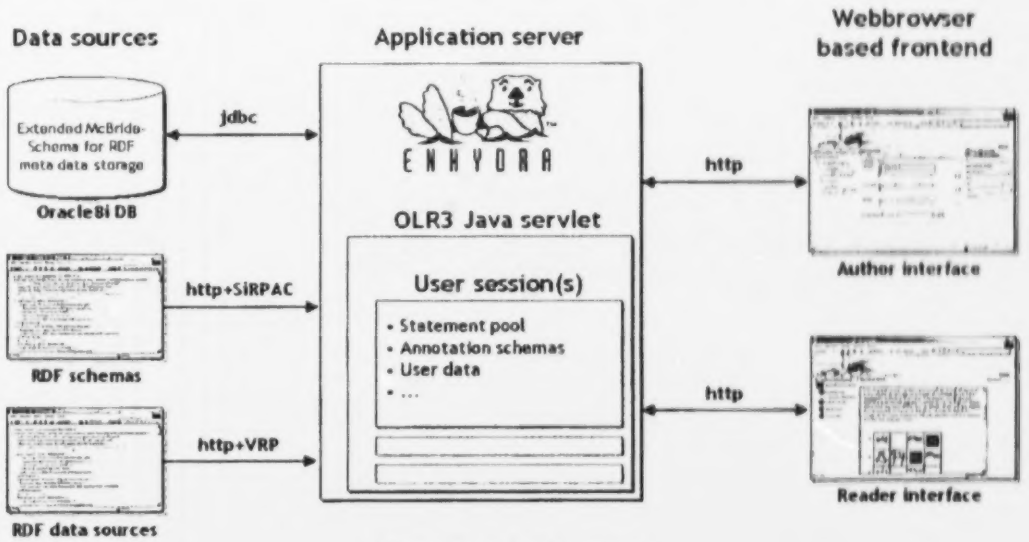

Figure 1: OLR Architecture

Web Interface

OLR3 provides a web-browser based metadata editor/viewer and two major user interfaces: The first one is used for readers preferring a more graphically oriented view and only minor functions for manipulation of the underlying metadata. The second one is designed for authors to provide a schema-driven and browser-based metadata editor with flexible binding to different RDF schemes.

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Learner Web Interface

Learners of a given course can navigate through an existing course structure, displayed as a tree and extended by additional, metadata-defined images for better understanding. As we will see in the second part of this paper we implemented two instructional models in our OLR3 prototype for the course "Introduction to Artificial Intelligence". Within that tree the user may select course elements, whose content will be displayed in the center of the screen. A specific engine prepares and filters the content, and displays it based on a stored layout. The reader interface also offers the reader the possibility of making minor additions to the metadata of a selected course element by providing functions like "add comment", "add bookmark", "add keyword to metadata" etc. All those additions can be made private or public to other course readers.

Author Web Interface

The second interface provides the actual metadata editor which is intended for course authors, who can navigate through the structure tree of a course and select any sub-element. All existing editable metadata for this element are shown in the center of the screen, and the user can choose from a set of existing RDF properties, to add to the metadata, or to modify the existing data. The author can also bind RDF schemes (e.g. DC, DCQ, LOM) stored on the Web to extend the set of available properties for annotation, or unbind RDF schemes, that are not needed anymore. A "toolbar" holds those bound RDF schemes and offers the possibility of navigating through their structure by displaying an expandable tree view of any available property.

Different Views on Learning Material: Three Models

Learning management systems and learning environments as well as standards for metadata in the field of learning often implement or address only specific learning and teaching principles, theories and models. These learning theories are addressed either implicitly or (sometimes) explicitly. This means that neither teachers nor learners can choose a way of learning suited best to their preferred learning strategy or learning style. In a life long learning context, however, learners have to be able to decide on learning needs themselves and should be able to choose a preferred way of learning themselves. This requires reflection on ones own strategies of learning and teaching. Rautenstrauch (2001) explains: *Life-long learning will be a learners own decision (...) the learner is mature (...) he will identify and define his own needs and prefered ways of learning (...) he will learn to learn self-organized, self-determined, and independent from predetermined curricula and institutional forms of organization.*

We therefore designed the Open Learning Repository (OLR3) open to different learning and teaching strategies. In order to be able to implement diverse learning models we separated different metadata-models: the *Domain Model* and the *Instructional Model*. Furthermore, we offer different navigational structures: guiding sequences (supporting learning processes) as well as links to related learning objects (supporting exploration and elaboration), in order to face the different needs of novices and experts. We implemented two different learning models which can be assigned to different paradigms/epistemologies: a learning sequence designed along Ausubel's theory of Expository Teaching (Ausubel, 1968), which is assigned to cognitivistic theory, and a PBL model (Problem-Based Learning) (Wiesenfarth, 1992) which is associated with situated approaches.

Modeling different spaces or metadata-models in OLR is a means of representing different views on learning material. In the OLR we have three main spaces to model different aspects/views: *Domain Model*, *Instructional Model*, *Structural and Cooperative Model*. These different models can be structured by different experts in the different fields (experts in the subject domain may structure the *Domain Model* whereas instructional designers may extend the *Instructional Model*)

Domain Model

In the *Domain Model* domain and subject specific ontologies are specified, mainly including MatterOfFactRelations, both hierarchical and associative (cp. Meder, 2000). This knowledge space includes structuring of subject specific knowledge, subject specific skills and competencies.

Instructional Model

There is no unique instructional ontology but different approaches, theories and models. In the Instructional Model instructional phases and relations are specified. They are derived from different instructional models and learning theories. Furthermore learning processes are modelled along different instructional principles (PBL, Case-based etc.). Trying to represent these aspects in learning object metadata, we realized that existing metadata standards do not address learning processes (Allert et al., 2002), an issue also discussed by Meder, who stresses, that learning objects should be defined in six dimensions (Meder, 2000), where one of these dimensions defines the position of an learning object within the process of knowledge acquisition: *A learning object must be defined in the dimension of logic-operative modes of processes, i.e. there are methods which determine the process of acquisition of knowledge. („Ein didaktisches Objekt muss bestimmt sein (...) in der Dimension logisch-operativer Verlaufsformen, d.h. es gibt Methoden – im definierten Sinne – die den Verlauf der Aneignung von Wissen bestimmen können")* (Meder, 2000)

Up to now we implemented two different instructional models derived from different principles and paradigms: Expository Teaching by Ausubel (cognistivism) and a Problem-based model (situated approach) (see Tab. 1).

Phases we modelled along the Expository Teaching by Ausubel (1968):	Phases we modelled along the PBL model of Wiesenfarth (1992):
Phases	**Phases**
Advance Organizer (orientation)	Set Goal
Progressive Differentiation (conceptualization)	Specify Criteria
Practice	Acquire Knowledge
Integrating and Connecting	Generate Ideas
	Realize Implementation
Relations between them are „followed by".	Reflect
	Generalize

Table 1: Phases modelled in OLR3

These different guiding structures (learning processes and phases), specified in the *Instructional Model*, serve as threads and address the problem of linking decontextualized objects to stringent learning sequences and coherent structures. We defined instructional roles of learning objects within each phase. The Expository model as well as the PBL model work as guidance to authors presenting learning material as well as to students navigating through the material. The PBL model also guides students structuring their own project work. The phases which are modeled in the *Instructional Model* represent the structure at the interface. The learner can choose from two views on the learning material: "learning sequence" (Expository model) and "problem solving path" (PBL model).

Structural and Cooperative Model

Whereas in the *Instructional Model* learning models and processes are specified in order to support guidance, in the *Structural and Cooperative Model* relations are specified in order to support exploration and elaboration. Course authors may use the Relations to integrate further material and learning objects, beyond the thread of guidance. There are different kinds of relations:

- Methodical and Structural Relations
- Cooperation-Supporting Relations
- Learner Activities.

Examples for methodical and structural relations are:

- Theory generalizes example.

- Exercise applies theory.

Entity	Relation	Entity
theory	generalizes	example
exercise	applies	theory
...		

Table 1: Methodical Relations specified in the *Structural and Cooperative Model*, expressed as Triple

In order to model these relations, each learning object must be categorized methodically. In this *Structural and Cooperative Model* learner activities are modelled, too. Examples for learner activities are:

- Add keyword to metadata
- Add relation
- Add comment

Cooperative relations are modelled to guide students cooperative work. Next to the "problem solving path" relations are offered which motivate students to compare the progression of their project with others' or to compare the organization and coordination of projects within teams. These relations are planned to be implemented in the OLR3.

Based on these models the new interface of the OLR3 will look as shown in Fig. 2. This new interface is based on results of the scenario-based-evaluation of the former version of OLR (OLR2).

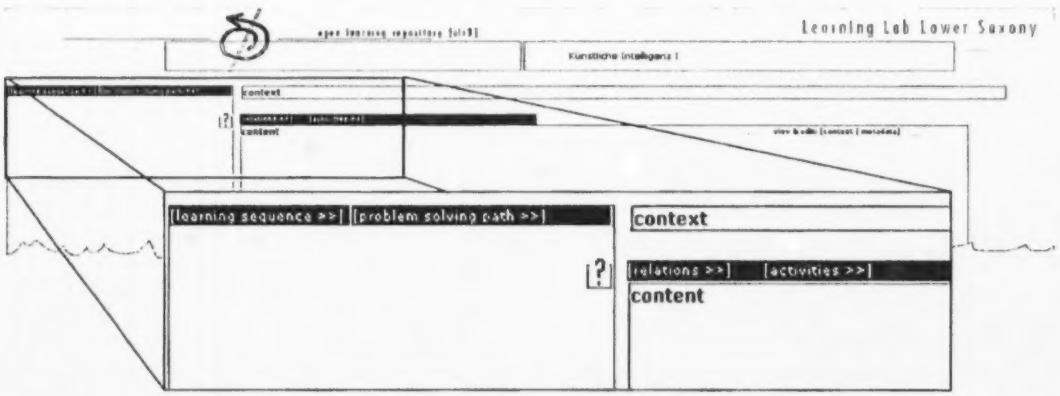

Figure 2: new interface of the OLR3

Scenario-Based Evaluation and Design

In this section different aspects of the scenario-based evaluation and design of the OLR will be highlighted. First the evaluation of the previous version of the OLR is briefly described. Then the impact of organizational and educational context for the design of a computer supported learning environment like the OLR3 is discussed. Furthermore the relevance of scenarios as a medium for communication will be stressed.

Evaluation of a Former Version of the OLR

The scenario-based[1] evaluation of the previous version of the OLR has been an important starting point for the design of our current version. In an evaluation survey 20 students, which had attended an introductory

[1] We use the term scenario to refer to a narrative description of a situation of use. (Carroll, 2000) states that a scenario is characterized by a setting, includes agents and actors with individual goals or objectives and describes in contrast to

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course on Artificial Intelligence, participated in semi-structured interviews. The lecture notes of this course on Artificial Intelligence had been provided to the students via the OLR. The aim of this survey was to explore how the OLR could be improved. On the basis of these interviews a scenario-of-actual-use was written. In addition the designers, teachers, and developers of the OLR were asked to write scenarios-of-intended-use in order to express their ideas of how the OLR should be used by the students. The comparison of the scenario-of-actual-use and the scenarios-of-intended-use revealed that the OLR had been used in a very restricted way by the students. Much of the functionality implemented in the OLR had not been used, or had been judged as not useful/necessary for reaching the course objectives. The survey is described in more detail in a technical report (Richter & Allert, 2002).

We are convinced that the mismatch between the use made by the students and the functionality implemented in the OLR can be assigned at least partly to the characteristics of the educational context in which the OLR was embedded. The students concentrated on objectives determined by the course and its embedding in the organizational structure (the course was held in a rather conventional way). These objectives contradicted main ideas underlying the design of the OLR. For example, while the OLR tries to provide a broad range of diverse material on a topic, this feature was at least unnecessary or sometimes even counterproductive to prepare for the exams which focused on the core material. As a consequence (besides changing the course structure and focus in the next semester) we suggest not only to implement different learning principles and modules but also help-files, which address the learners' reflection of learning strategies, acknowledging the fact that choosing from different learning modules requires reflection on ones own activities of learning. We are going to create the help-files on the basis of scenarios that describe the different underlying educational ideas on the level of concrete human activities.

The Meaning of Contextual Conditions for the Design of the OLR3

The evaluation revealed that it is crucial to address the educational context as well as characteristics of the learners more carefully in the design of the OLR3. The most important aspect of the educational context that influences the use of learning materiasl are the (often implicit) learning objectives. While in many educational settings some learning objectives as the acquisition of domain specific knowledge are named explicitly, other possible learning objectives stay more or less implicit., for example the acquisition of social competencies.

A precise description of implicit and explicit learning objectives within a given educational setting and their possible impact on students activities are therefore very important to make comprehensible design decisions. Only if conflicts between the learning objectives within a given educational setting and the learning objectives of the eLearning system are anticipated, it will be possible to decide if the system should be adapted to the educational setting or vice versa. This problem will be even more important if the learning system is constructed on a special educational model with explicit learning objectives and a certain conception of the learner. We assume that focussed changes in learning can only be fruitful in interaction with organizational changes (lecture and exams etc.) – nothing will not change if we simply offer a new e-Learning system to the students. The use of a learning environment such as the OLR3 has therefore to be understood as a part of more complex and longer lasting students' learning activity.

The educational setting with its implicit and explicit learning objectives and their possible impacts on students activities will constitute the context, which is addressed by scenarios written by all stakeholders. Scenarios of use appear to be an adequate way to describe the possible impacts of the context, because they force the writer to think about the specific behaviour of the user.

Scenarios as a Medium for Communication

Beside the fact that scenarios seem to be an adequate way of describing the use of a certain artefact on different levels of abstraction and can serve to highlight different perspectives on one task they additionally serve as a medium for communication between all involved stakeholders. A collective base for communication is of great importance because of the multidisciplinary design team involved in the design of the OLR3, consisting of instructional designers, computer scientists and teachers. In the development of any kind of educational material many different variables like the learning content, the underlying instructional models, characteristics of

conventional Use-Cases more complex sequences of human action. We apply situations of use in a very broad sense., for example, attending a lecture by a student is a situation of use.

the learner, characteristics of the educational context, and technological requirements have to be taken into consideration (cp. Tergan, 2000). It is unrealistic to recommend that every stakeholder has expertise in all the addressed topics. While the cooperation of a multidisciplinary design team allows to address many relevant topics it is still necessary (and sometimes even more important) to find ways to communicate the different ideas, concerns etc. within the design team. Scenarios seem to provide such a collective base for communication within the project. The necessity to formulate the possible consequences of certain variables, theories etc. on the concrete behaviour of an actor can assure the necessary information to make informed design decisions, and allows them to be communicated to the whole team. An adequate medium for communication is also an important condition to understand already made design decisions and as a starting point for further evaluation procedures.

Further Work

We are currently extending OLR functionality by a new user-interface as mentioned before. On the one hand the design of the new user-interface as well as the help files will be based on the results of the evaluation of the second generation of OLR. On the other hand the design will be guided by new scenarios-of-use that will address pedagogical theories and general conditions of the educational setting explicitly. We will also change the educational setting in which the OLR3 will be used in the next year to support a broader use of the OLR3 and the embedded learning materials. Good structured learning materials are very important for conventional learning and teaching, but appropriate and well structured learning materials for e-learning are absolutely crucial.

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